

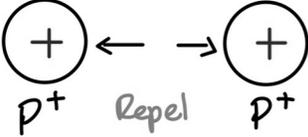
## Subatomic Particles

### Subatomic Particle Interaction

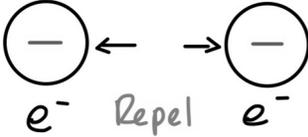
In the atom, subatomic particles interact based on their charges...

Proton (+): Proton (+) - Repulsion  
 Electron (-): Electron (-) - Repulsion  
 Proton (+): Electron (-) - Attraction

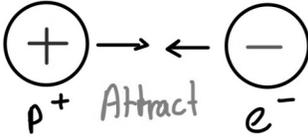
**Attraction** pulls subatomic particles towards each other, while **repulsion** pushes subatomic particles apart in the atomic structure



$p^+ - p^+$   
(nucleus)



$e^- - e^-$   
(orbital)



$p^+ - e^-$   
(nucleus to orbital)

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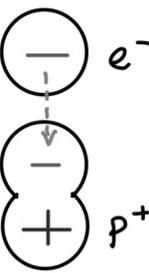
## Subatomic Particles

### Results of Interactions

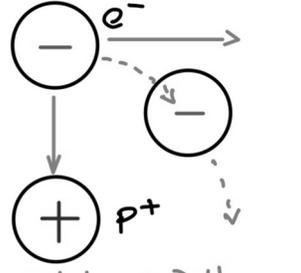
Attracting particles will combine together when directly interacting

**Proton ( $p^+$ ) + Electron ( $e^-$ ) = Neutron ( $n^0$ )**

Within atoms, when subatomic particles attract the negative electron ( $e^-$ ) will travel opposite that of the pull of the proton ( $p^+$ ). This interaction leads to **circular  $e^-$  paths**



Direct attraction  
( $p^+ + e^- = n^0$ )



Rotational Path  
(movement, attract balance)

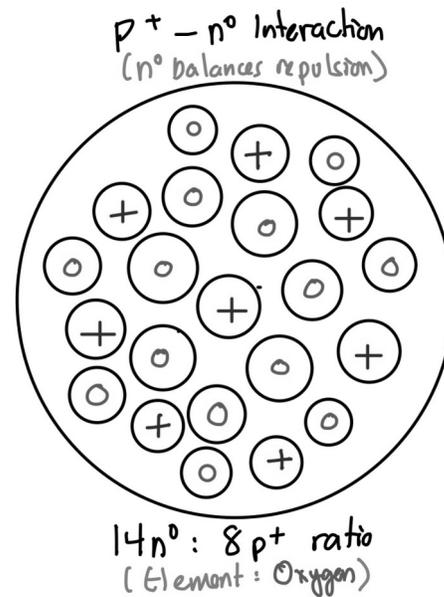
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## Subatomic Particles

### Nucleus Interactions

The protons ( $p^+$ ) within an atom repel other protons. To keep protons in the atom, neutrons ( $n^0$ ) reduce the repulsion by sitting between the protons ( $p^+$ ). This interaction is called *proton ( $p^+$ ) – neutron ( $n^0$ ) shielding*

*Shielding* also affects the attraction between the protons ( $p^+$ ) and electrons ( $e^-$ ) within the atom



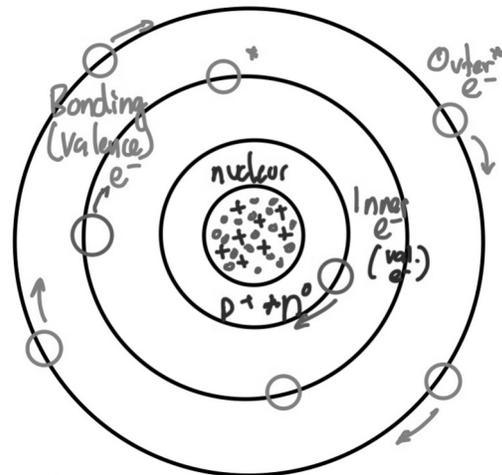
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## Subatomic Particles

### Atomic Orbital Theory

In the *Bohr Atomic Model*, electrons travel around the atom in *orbits*, or circular paths due to the proton–electron interaction and shielding

Electrons fill around the atom in *quantized (numbered) levels*, known as *energy levels*. Electrons in the outer most level are known as *bonding, or valence electrons ( $e^-$ )*. Lower level  $e^-$  are *inner electrons ( $e^-$ )*



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## Subatomic Particles

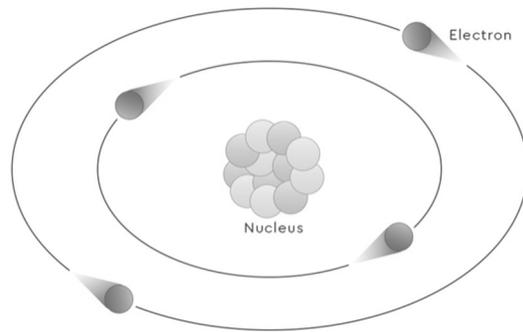
### Uncertainty Principle

The *Heisenberg Uncertainty Principle* states that you can't know both the *position of a particle* and the particles momentum ( $p$ ).

Momentum ( $p$ ) is the multiplication of the particle mass and particle velocity (*speed*)

$$p = m \times v$$

Momentum can be described as the difficulty in changing particle direction



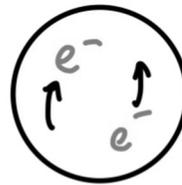
The *Heisenberg Uncertainty Principle* means we can't know the exact position of path of an electron ( $e^-$ ) in the orbit of an atom disproving the *Bohr Model* orbital pathways

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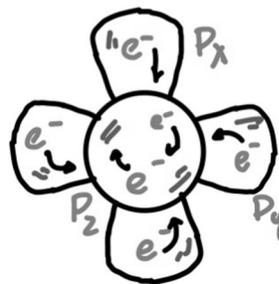
## Subatomic Particles

### Electron Cloud Theory

In the *modern atomic theory* electrons exist in areas within the atoms called *orbitals*. The orbitals are commonly labeled as s (*spherical*), p (*peanut*), d (*double peanut*), and f (*flower*) shapes. The p, d, and f orbitals contain many lobes, or suborbitals ( $p = 3$ ,  $d = 5$ , and  $f = 7$ ), with each suborbital containing up to 2 total electrons with opposite spins



s-orbital  
(spherical)  
2  $e^-$ , opp. spins



p-orbital  
(peanut)  
3 suborbitals  
6  $e^-$ , opp. spins  
2  $e^-$  per sub.

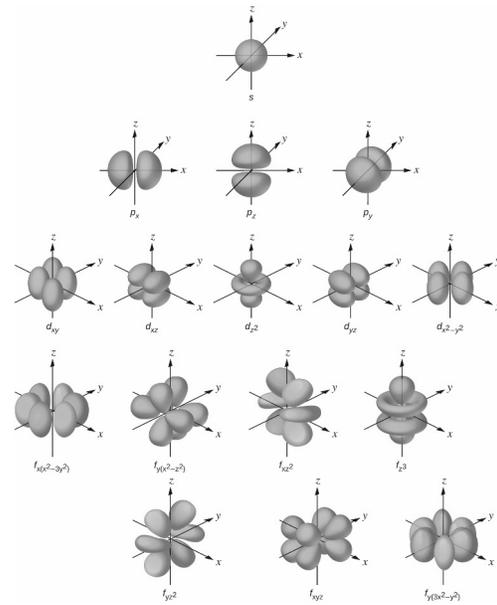
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## Subatomic Particles

### Electron Filling in Orbitals

In the *modern atomic model*, electrons always fill the atom from the bottom up using a specific order, known as the *electron orbital filling order*.

Atoms need to *minimize energy*, with electrons closer to the atom being lower energy overall. The number of *total electrons* ( $e^-$ ) determines the filling of the atom overall



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## Role of Subatomic Particles

The modern atomic model contains protons, electrons, and neutrons (*+, -, and neutral*)

### Protons

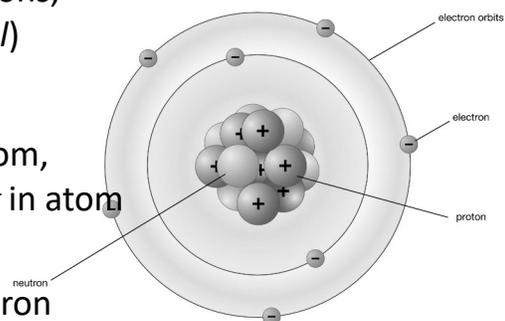
In nucleus (*center of atom*), identifies atom, provides attraction interaction holding  $e^-$  in atom

### Electrons

Interactions between atoms due to electron transfer (*bonding*), absorbs extra atomic energy

### Neutrons

Provides proton shielding, keep atom stable



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